

DAQ and Thresholds

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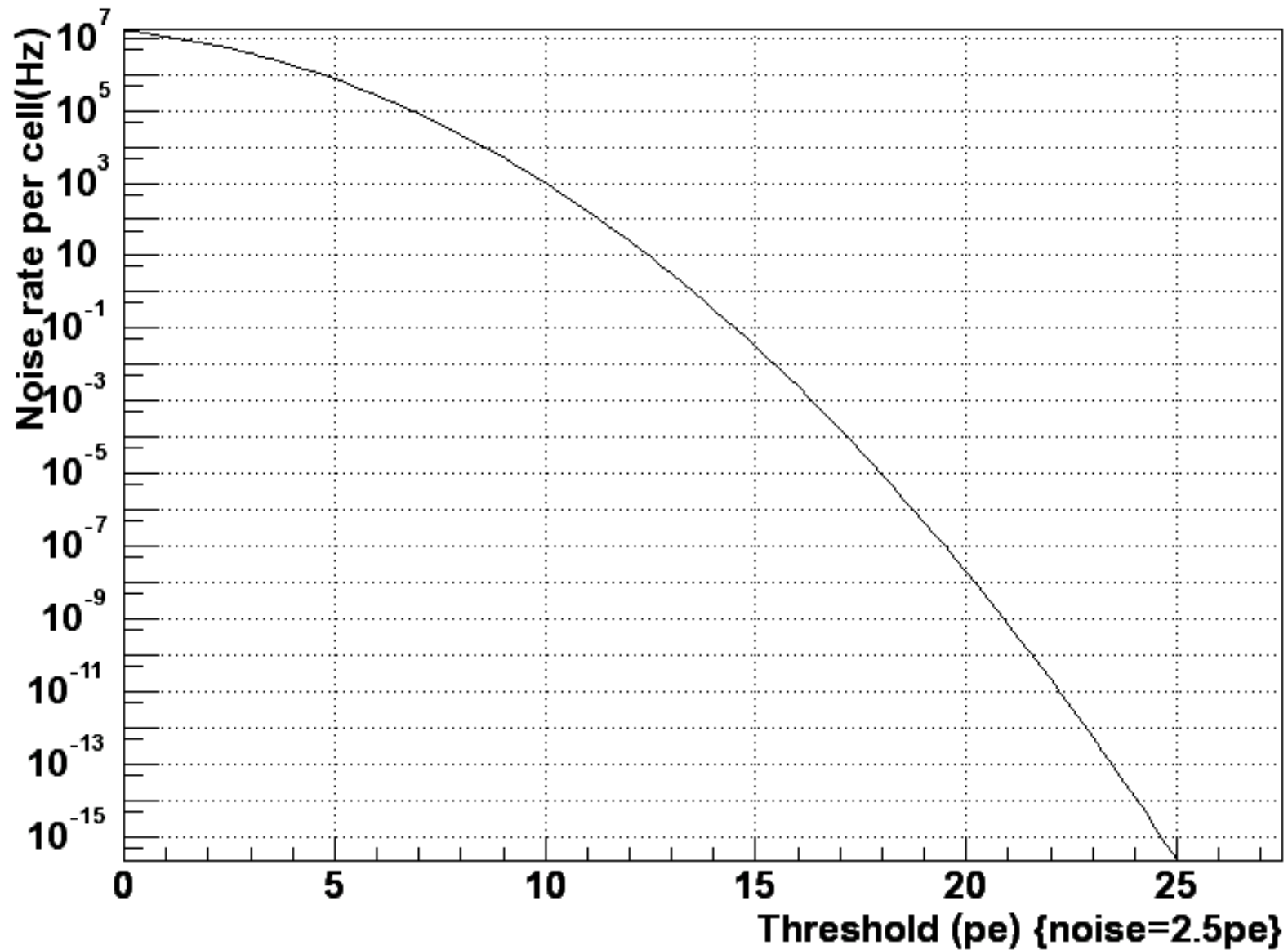
Data Rates

- Driven by Cosmic Ray induced Muons
- $\sim 250\text{kHz}$, leading to $\sim 400\text{Hz/channel}$ or 12kHz/module rate
 - 120kB/module/s
 - But $23,808 * 120\text{kB/s} = \sim 3\text{GB/s}$

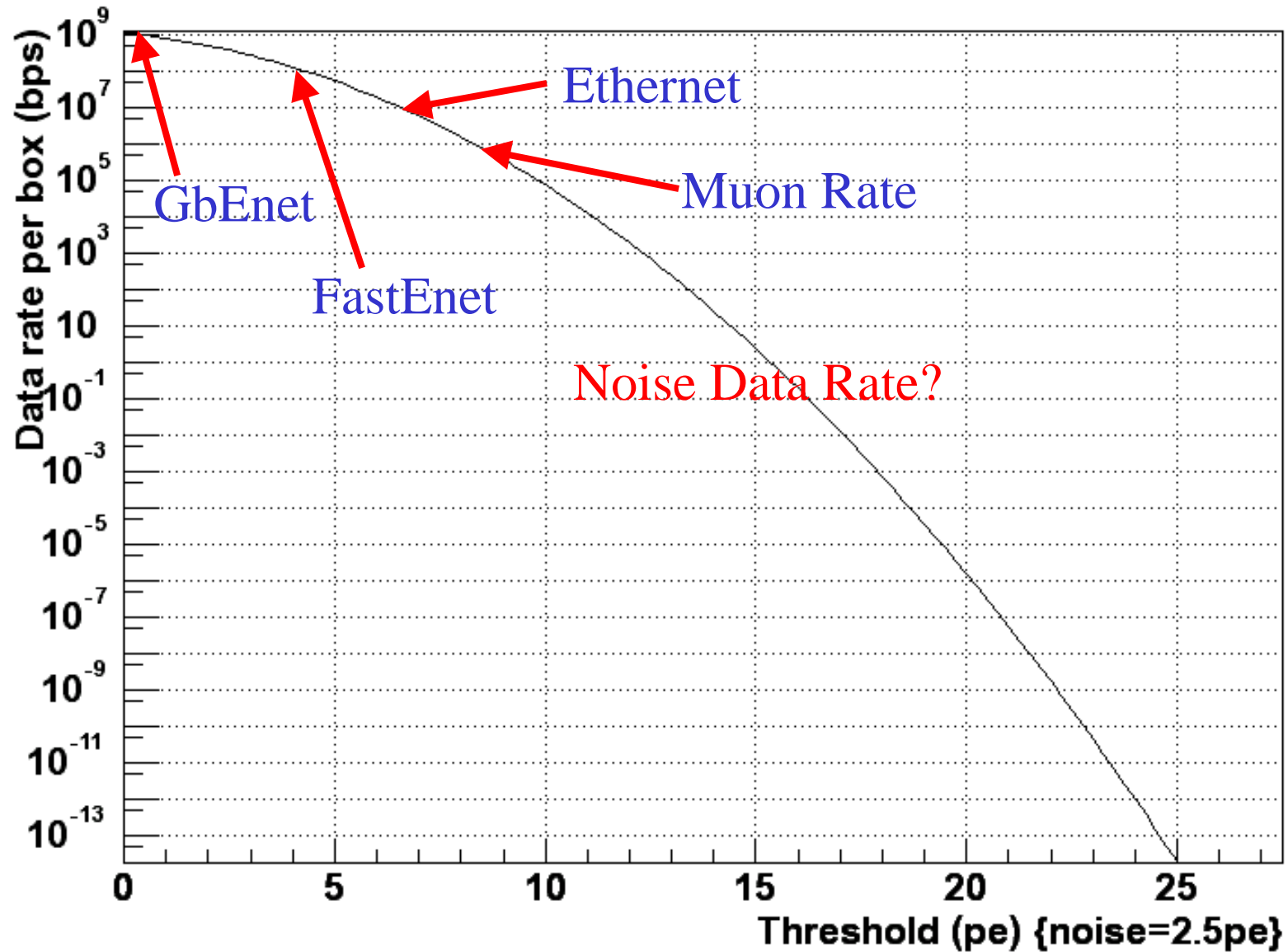
Noise Data Rates

- Determined by noise level and threshold
- Noise ~Gaussian $\sigma=2.5\text{pe}$
- Data output 10 bytes/hit above threshold
- 10^6 time slices per second
- Maximum data rate—
$$32\text{chan} * 10\text{bytes} * 8\text{bits/byte} * 10^6 = 2.5\text{Gbps/box}$$
- $23,808 * 2.5\text{Gbps} = \sim 60\text{TB/s}$

Noise Rate per box vs. Threshold



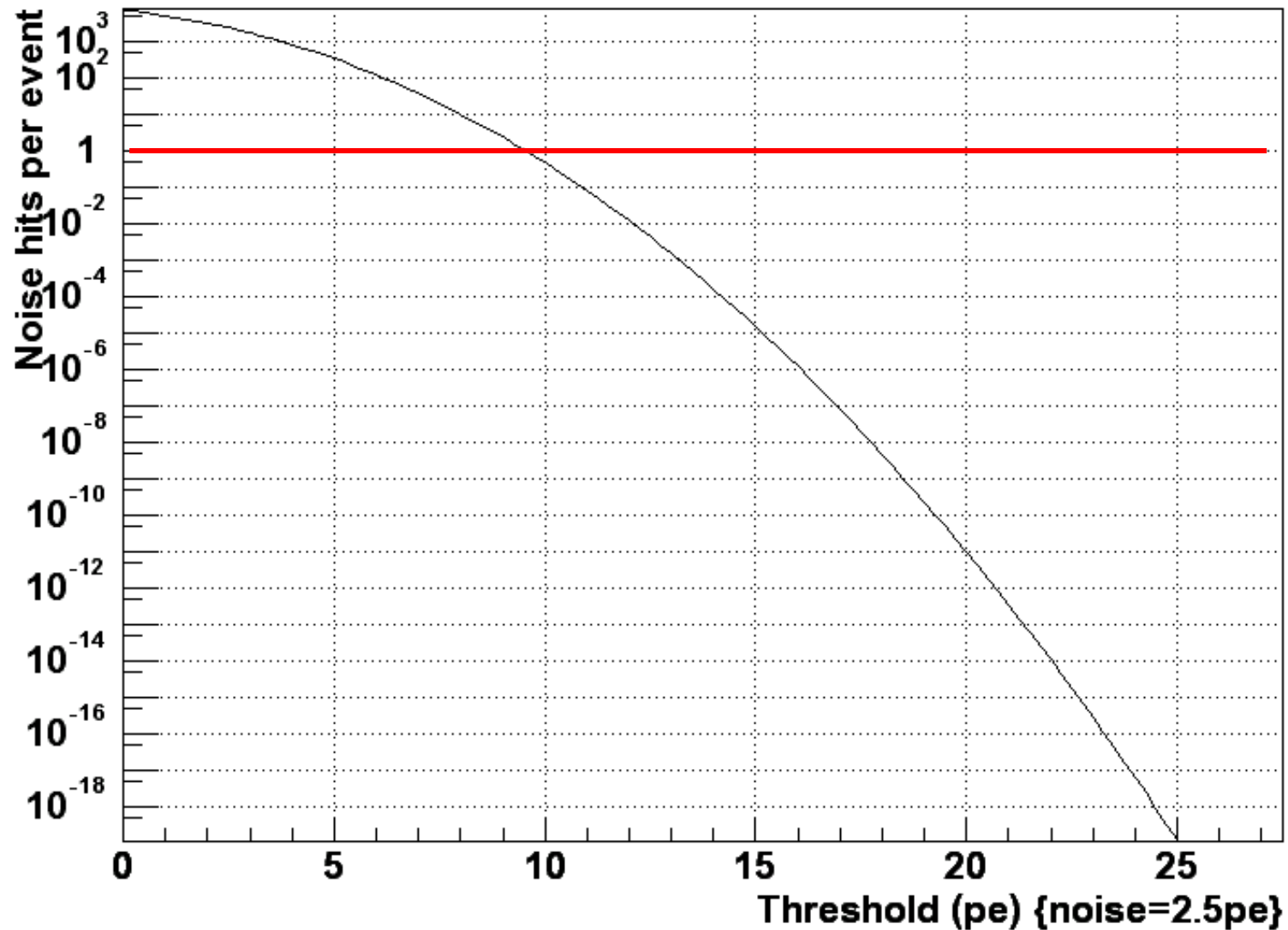
Noise Data Rate vs. Threshold



Noise in Events

- Largest events are quasielastic numucc events.
- Assume $\sim 2\text{m}$ in each view, 50 strips
- ~ 100 planes/GeV, ~ 300 planes long
- ~ 15000 strips in an event
- Use the noise rate and the number of strips to calculate the noise contamination of an event.

Noise per event vs. Threshold



Conclusions

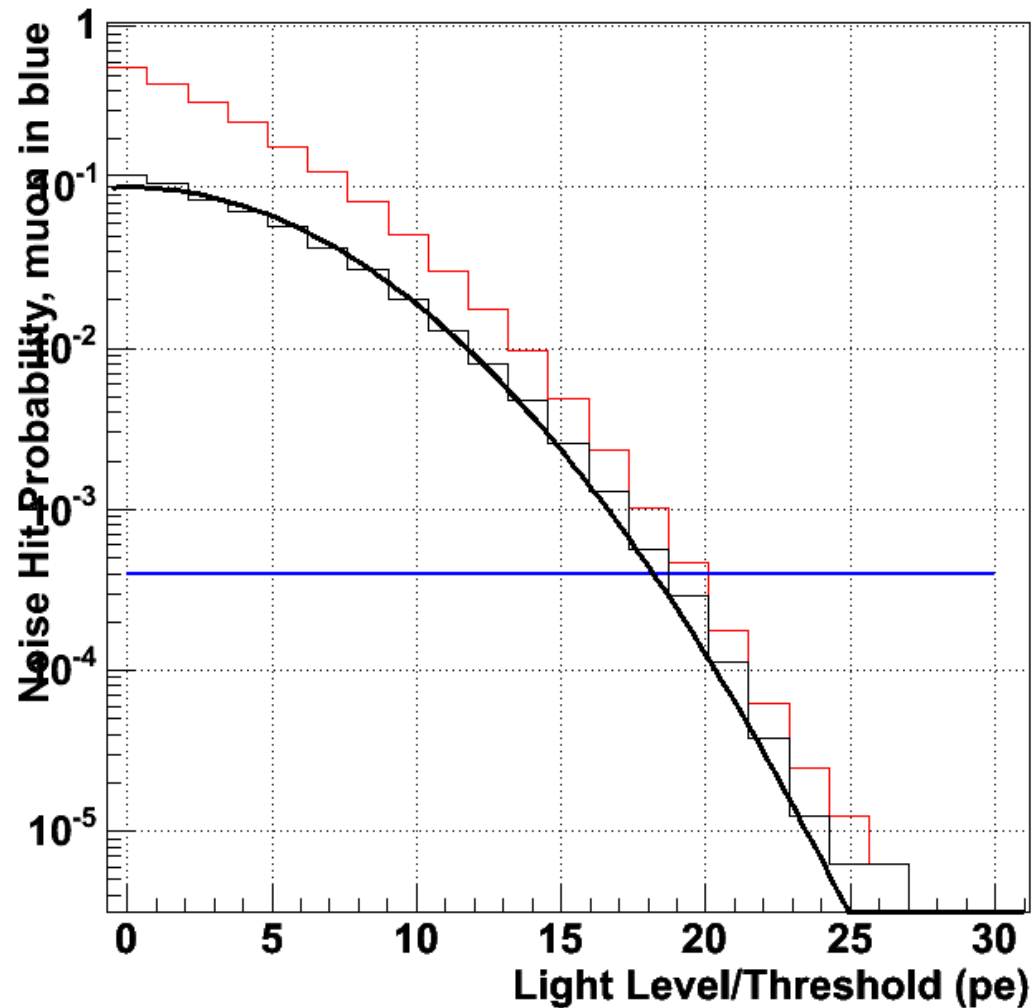
- DAQ rate limit (ethernet) limits threshold to ~8pe minimum
- Contamination of events ~10 noise hits per event at 8pe, ~1 hit/event at 9pe.
 - 10 hits at 8pe $\approx < 30\text{MeV}$
- 8pe = 3.2σ for noise of 2.5pe
- Add some conservatism, demonstrated 3.1pe noise so far, so use $3.2*3.1=10\text{pe}$
 - (had been using 20 before)

But Wait, There's More

- There is a non-Gaussian tail associated with the APD system.
- Assuming that this noise will be present, it will limit the threshold.

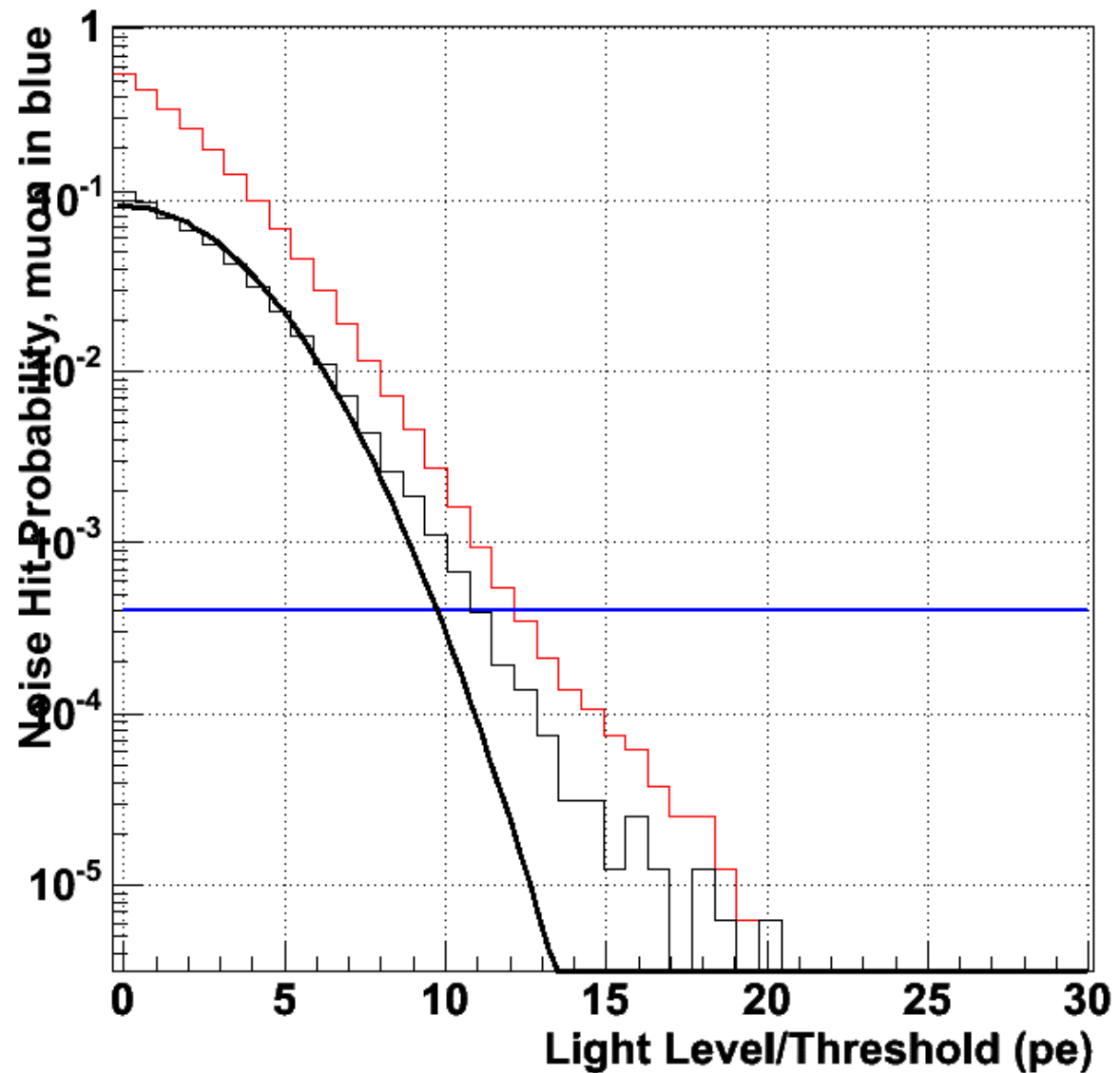
Threshold limits in reality (M=50)

At gain of 50
the threshold is
~21pe to keep
rate limited to
 $\frac{1}{4}$ of muon rate



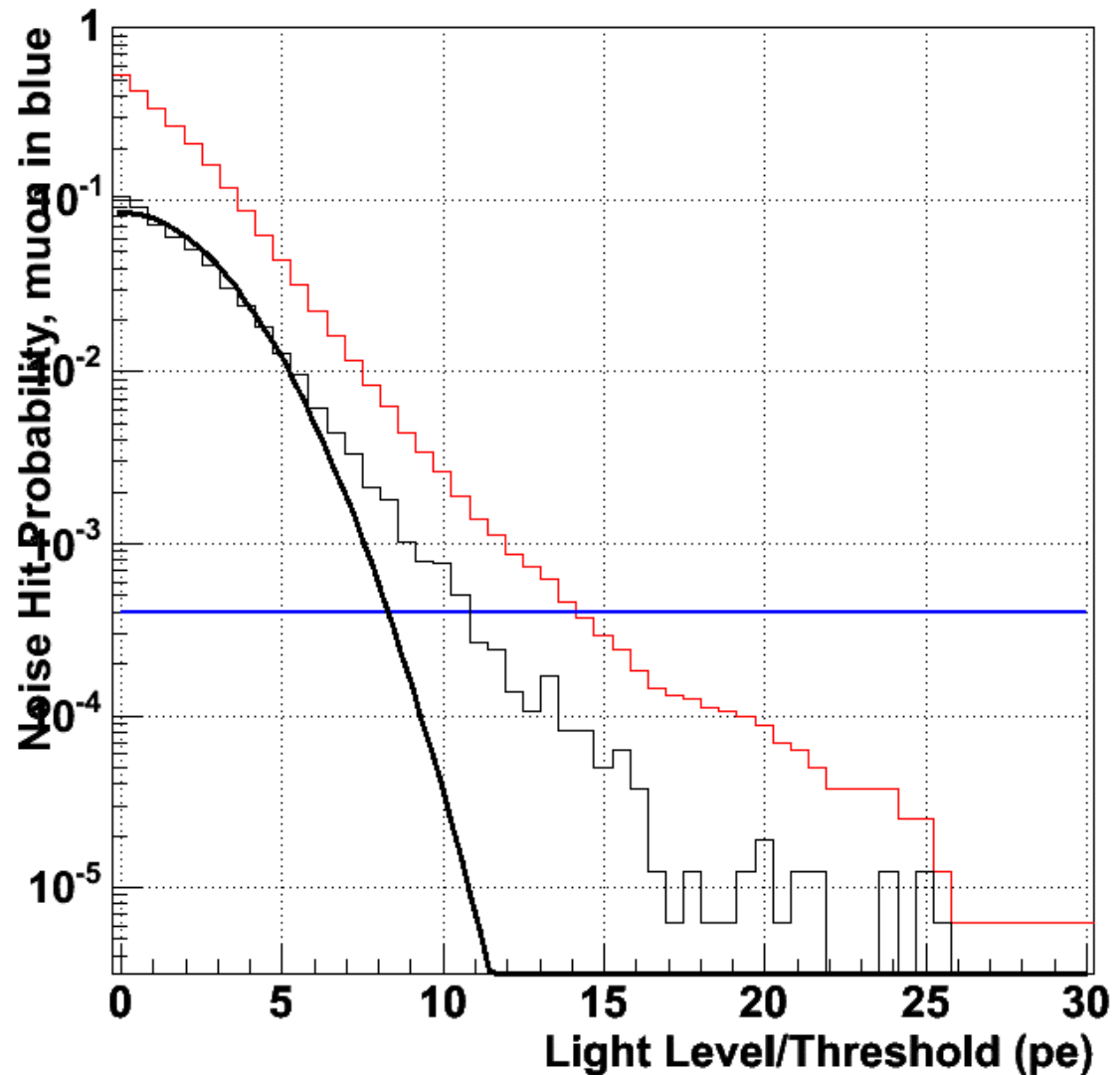
Threshold limits in reality ($M = 100$)

At gain of 100
the threshold is
~15pe to keep
rate limited to
 $\frac{1}{4}$ of muon rate



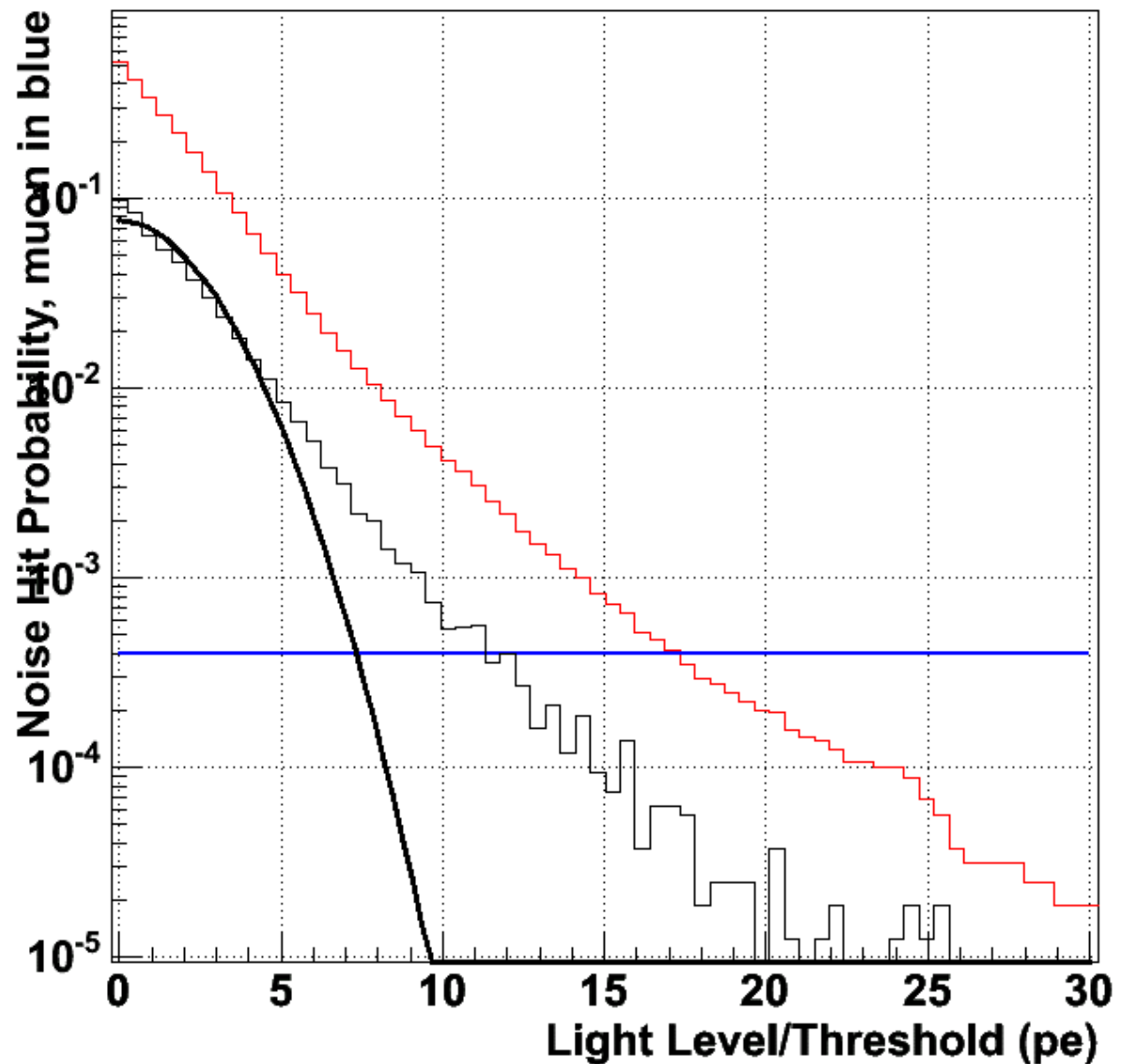
Threshold limits in reality (M=125)

At gain of 125
the threshold is
~18pe to keep
rate limited to
1/4 of muon rate



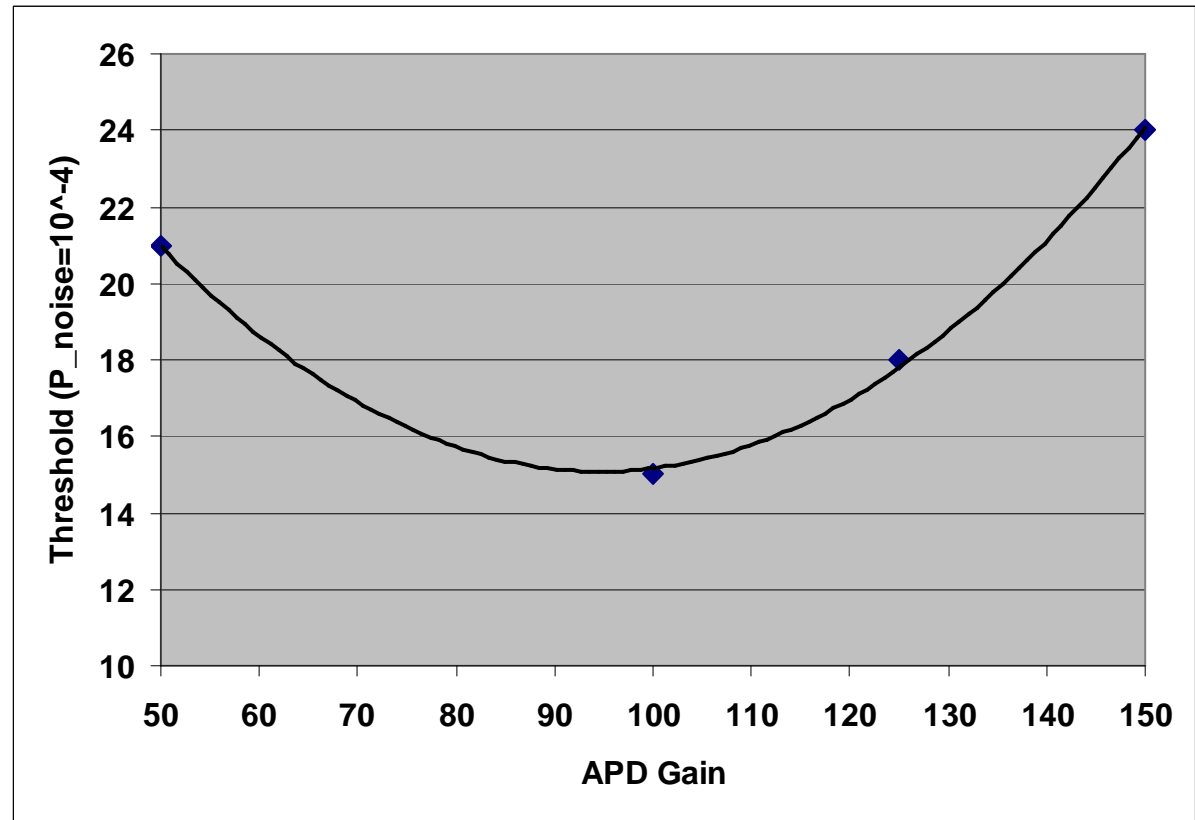
Threshold limits in reality (M=150)

At gain of 150
the threshold is
~24pe to keep
rate limited to
 $\frac{1}{4}$ of muon rate



Threshold vs. Gain

Let Excel fit a parabola, and it looks like $M=100$ is not far from optimal



Conclusions 2.0

- Noise is not entirely described by a Gaussian.
- Evidence not shown, but this tail can be reduced by further cooling
- It may optimize better to cool more and reduce the light output.
- The non-Gaussian tail limits the threshold in reality to about 15pe for a noise rate 4X less than the muon rate.